# SAFEGUARDING BANANA DIVERSITY

## at the Bioversity International *Musa* Germplasm Transit Centre

Banana is one of the world's favourite fruits. Grown throughout the tropics and subtropics, bananas provide food, nutrition and income to hundreds of millions of people. They are a staple crop in many countries, such as Uganda, Rwanda and Burundi, where people consume up to 11 bananas each per day. In Uganda, the local word for bananas – *matooke* – means food.

Globally, a wide diversity of banana (*Musa* spp.) is cultivated and consumed – it is estimated that there are more than 500 banana varieties. However, over 40% of all cultivars grown worldwide belong to only one genetically narrow subgroup of dessert bananas – the Cavendish. The tendency to replace local diversity with a single high-yielding cultivar as a monocrop is increasing every year, even in smallholder fields, sometimes resulting in complete loss of local diversity. The risks associated with relying on one or a few genetically similar cultivars of a crop are well known, as the Irish Potato Famine demonstrated in the 19th Century.

There is an **urgent need to protect and further explore the diversity of banana**, both wild and cultivated. A broad genetic base is necessary to make the crop more productive, resistant to pests and diseases, and resilient to climate change.

◢ **Cover photo:** *In vitro banana collection at the Bioversity International Musa Germplasm Transit Centre, Leuven, Belgium. Credit: Bioversity International/N.Capozio*

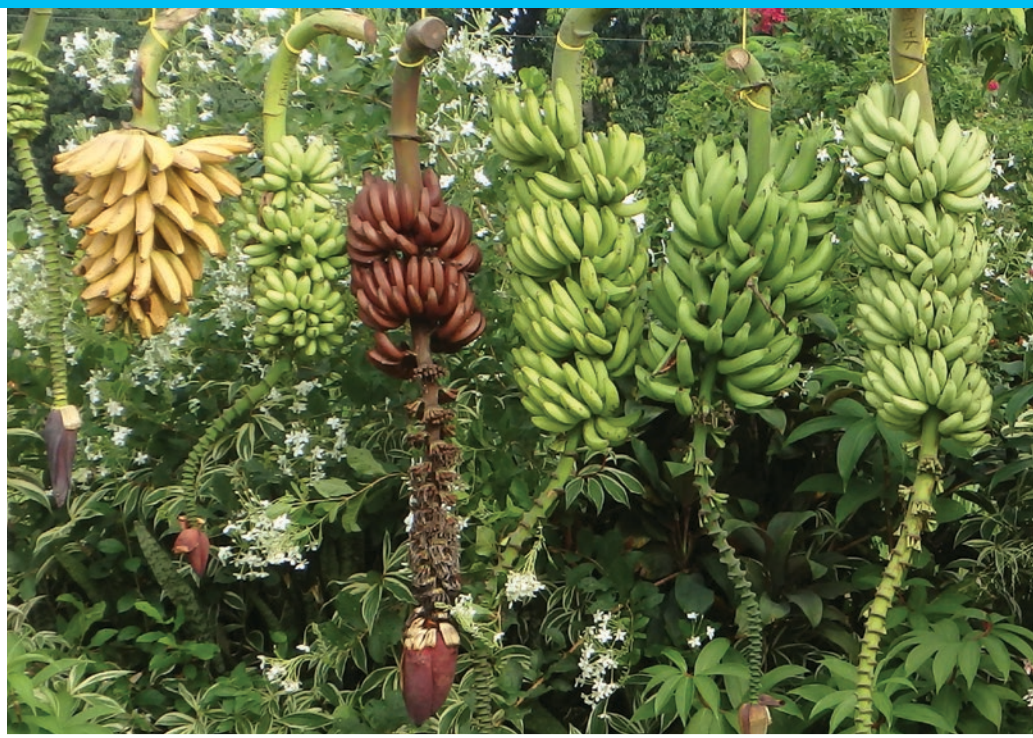
◢ **Photo 1:** *Bananas at the Mbarara field collection in Uganda. Credit: Bioversity International/N.Capozio*

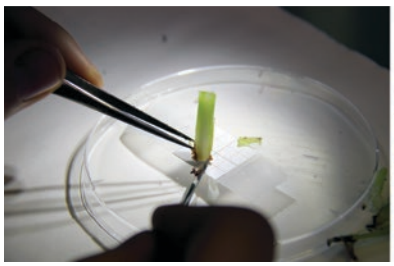
## The Bioversity International *Musa* Germplasm Transit Centre (ITC)

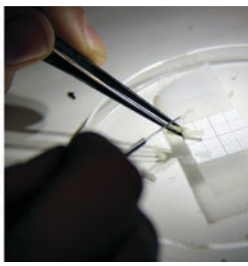
The Bioversity International *Musa* Germplasm Transit Centre (ITC) is home to the world's largest collection of banana diversity.

Its mission? To contribute to the **secure long-term conservation of the entire banana genepool** and hold the collection in trust **for the benefit of current and future generations** under the auspices of the Food and Agriculture Organization of the UN.

Founded in 1985, the ITC is managed by Bioversity International and hosted at the Katholieke Universiteit Leuven, Belgium. The collection contains more than 1,500 samples (or as scientists say, accessions) of edible and wild species of banana, and the collection continues to grow as new specimens are collected in the crop's centres of diversity in South-east Asia, and East and West Africa.







## Conservation and distribution

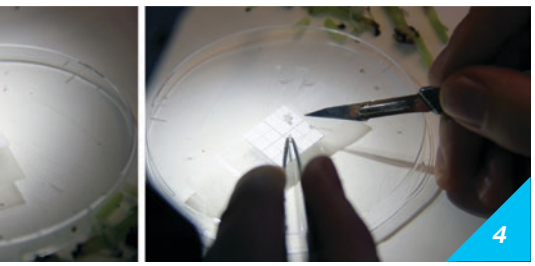
Banana is a vegetatively propagated crop: it does not reproduce through seeds, and new plants grow from young shoots that arise from the parent plant. This is why in genebanks, bananas are conserved in the field or as small plantlets *in vitro* (in test tubes). At the ITC, the collection is maintained *in vitro* under slow growth conditions at 16°C. Looking after this collection and ensuring that plants stay healthy is a labour-intensive and year-round challenge.

The collection is also internationally renowned as the safest source of healthy banana germplasm. For material to be exchanged, it first needs to be freed of pests and pathogens including fungi, bacteria and viruses. The ITC tests its accessions and distributes only those that are free of pests and pathogens.

The material is shared under the Multilateral System of Access and Benefit Sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture, an international agreement to facilitate the exchange of plant genetic resources and ensure the fair and equitable sharing of benefits arising from their use.

Obtaining material from the ITC is easy. Samples are available upon request on the *Musa* Germplasm Information System (MGIS) portal, the most extensive source of documentation on banana genetic resources, containing information on nearly 5,000 accessions from the ITC and 12 national banana germplasm collections worldwide. Every day, samples of 3 accessions are distributed from the genebank to users worldwide.

In 30 years of activity, the ITC has distributed over 17,000 banana samples to researchers and farmers in 109 countries. On average, 75% of the samples go to users in the main banana growing regions – Africa (27%), the Americas (25%) and Asia and Pacific (23%) with the remainder sent to universities and research centres in Europe.



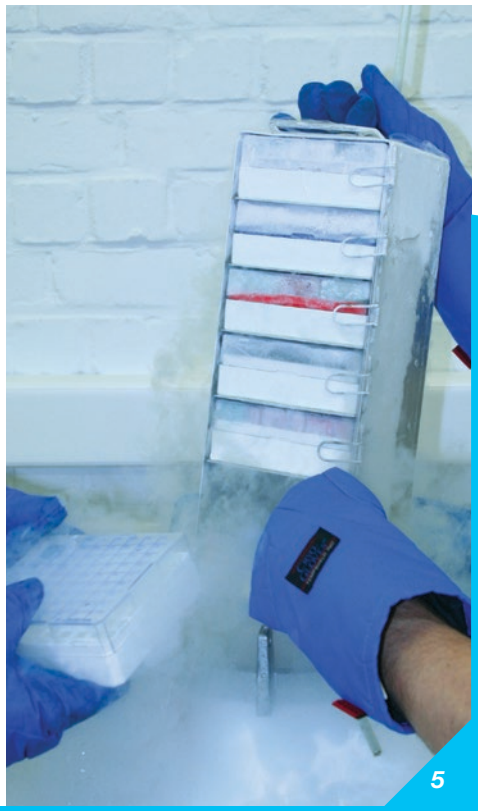
## Cryopreservation

*In vitro* banana samples stored under slow growth conditions need to be transferred to fresh growth medium once a year, and after a certain number of years, if necessary, replaced with fresh material grown out in the greenhouse to avoid the risks of unwanted variations that may happen spontaneously when plant tissues are kept in test tubes for an extended period of time.

For security and long-term storage, banana accessions are also frozen to -196 °C, the temperature of liquid nitrogen, in a process called cryopreservation. The extremely low temperature stops all biological and chemical processes, so the plant remains unaltered for thousands of years and can be revived into full banana plants as needed.

More than 60% of the banana accessions conserved in Leuven are cryopreserved, and, for security reasons, safety duplicated at the Institut de recherche pour le développement (IRD) in Montpellier, France, 1,000 kilometres from Leuven. The ITC is working hard to have the entire collection cryopreserved in the foreseeable future.

The ITC is a global centre of excellence on plant cryopreservation, having successfully developed protocols for cryopreserving over 30 crops, including apple, banana, cassava, olive, potato and tomato. Over the past 20 years, scientists at the ITC have trained around 100 researchers from 44 countries on plant cryopreservation techniques, resulting in the adoption of new conservation technologies for specific crops, and publication of research papers and development of new projects.



◢ **Photo 2:** *At the ITC, bananas are conserved in test tubes at 16 °C.*
*Credit: Bioversity International/N.Capozio*

◢ **Photo 3:** *Banana diversity conserved at CARBAP, Cameroon.*
*Credit: Bioversity International/R.Chase*

◢ **Photo 4:** *Excision of the banana meristem tip that will be cryopreserved. A meristem is the plant tissue that contains undifferentiated stem cells (meristematic cells) that can give rise to various plant organs and keep the plant growing.*
*Credit: Bioversity International/N.Capozio*

◢ **Photo 5:** *Banana accessions cryopreserved at the ITC. Cryopreservation involves plunging plant material in liquid nitrogen (-196°C).*
*Credit: Bioversity International/B.Panis*

◢ **Photo 6:** *Orange-fleshed Fei banana, rich in vitamin A.*
*Credit: Bioversity International/A.Vézina, courtesy of www.musarama.org*

## Research for more nutritious and resilient banana production systems

In addition to conservation purposes, Bioversity International uses the genebank to carry out research that can benefit farming communities around the world.

### Vitamin A-rich bananas

Every year, vitamin A deficiency causes half a million children to go blind. Half of those die from infections.

Many of these children live in Africa where bananas are the fourth most important food crop – swapping one variety for a vitamin A-rich variety could make all the difference.

Bioversity International screened more than 400 varieties to identify those with high levels of carotenoids – pigments that the human body can convert into vitamin A. Through the ITC, a number of varieties that originated in Asia and the Pacific were introduced to Burundi and the Democratic Republic of Congo. After testing these varieties across different growing cycles and agroecological zones, as well as in local food dishes, Bioversity International and partners distributed planting material to more than 500 farmers. The selected bananas have levels of carotenoids that are high enough to meet a child's recommended daily needs for vitamin A by eating just one banana. In addition, a training programme on production, post-harvest handling and nutrition has so far reached over 5,000 community members.

## Drought-tolerant bananas

Given the predicted rise in temperature in the tropical and subtropical areas — where bananas are cultivated — there is a need for solutions that can make banana production less dependent on water. Exploiting the fruit's genetic diversity to find drought-tolerant varieties and traits is an important strategy to successfully move in this direction.

What better place than the ITC to study banana genetic diversity? Through phenotyping — the science that characterizes and quantifies complex plant features such as growth, yield and stress tolerance — Bioversity International and the Katholieke Universiteit Leuven are studying the drought tolerance of banana varieties held in the collection.

Varieties identified as drought-tolerant will be tested in farmers' fields, helping production systems to be more diverse and resilient. At the same time, a better understanding of the genetic traits will speed up the breeding process for new drought-tolerant varieties.

## Resistance to Panama disease

Considered to be one of the most devastating diseases in banana, Fusarium wilt (also known as 'Panama disease') has wreaked havoc on global banana production for decades. Using resistant cultivars is the only viable option in the fight against this deadly disease.

A new strain of Fusarium wilt — called Tropical Race 4 or TR4 — has recently reached Africa, where millions of people depend on the East African Highland bananas (EAHB) for food and livelihood security.

Bioversity International is researching ways to prevent the spread of TR4, as well as disease management strategies, including the use of resistant cultivars.

Through the ITC, Bioversity International sent samples of EAHB to infected areas in China and the Philippines, to see how they would react to the virulent fungal strain. The results are promising: East African Highland bananas are not very susceptible to the disease.

*The Bioversity International Musa Germplasm Transit Centre is supported by the CGIAR Research Program for Managing and Sustaining Crop Collections, the CGIAR Research Program on Roots, Tubers and Bananas, CGIAR Fund Donors, the Crop Trust, BMZ - Federal Ministry for Economic Cooperation and Development, the Belgian Development Cooperation, KU Leuven - Belgium*

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◢ **Photo 7:** *Measuring the evaporation rate of banana plants at the ITC. The purple light is due to the combination of red and blue light, necessary for the plant to perform photosynthesis.*
*Credit: Bioversity International/N.Capozio*

◢ **Photo 8:** *Transporting bunches of East African highland bananas by bicycle in southwestern Uganda.*
*Credit: Bioversity International/N.Roux*

◢ **Photo 9:** *Bananas grown with other crops in Tamil Nadu, India.*
*Credit A. Vezina/Bioversity International*